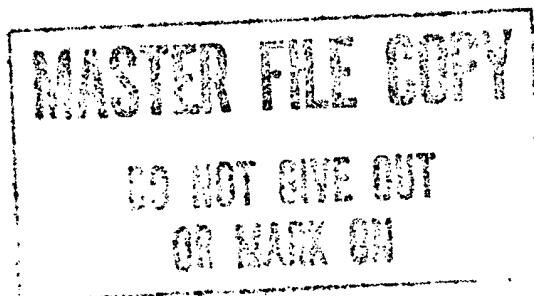


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## Soviet Oil Production Through 1990: Hard Choices Ahead

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A Research Paper

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# **Soviet Oil Production Through 1990: Hard Choices Ahead**

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**A Research Paper**

This paper was prepared by [redacted]  
[redacted] Office of Soviet Analysis.

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Comments and queries are welcome and may be  
directed to the Chief, Economic Performance  
Division, SOVA [redacted]

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**Soviet Oil Production  
Through 1990:  
Hard Choices Ahead**

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**Summary**

*Information available  
as of 15 October 1986  
was used in this report.*

We believe the USSR will not be able to sustain for long the pickup in oil production achieved in 1986. This increase—from an average of 11.9 million barrels per day (b/d) in 1985 to 12.2 million b/d during January-August 1986—resulted from the conjunction of favorable but limited developments: the return of a large number of idle wells to active status and a sharp increase in drilling activity. Our best judgment is that oil production is likely to begin declining sometime in 1987 and by 1990—even if Moscow doubles investment in 1986-90 from the 1981-85 level—will reach a rate of about 11-1/4 million b/d:

- The natural aging and depletion of existing oilfields, exacerbated by continuing overproduction, severely limits the potential for growth of oil production in the West Siberian region during 1986-90.
- Although there is potential for the discovery of giant oilfields in the Barents Sea, none have yet been found. Significant production from any field in that region is unlikely to commence before 1990.

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With better-than-expected results in drilling and well completions in West Siberia and marked improvement in oilfield equipment quality and supply, oil production could remain about 12 million b/d through 1990. On the other hand, it could fall to about 10-1/2 million b/d by 1990 if the Soviets encounter greater difficulties and lower productivities in West Siberian field development than anticipated, if they are unwilling to continue boosting investment to provide large increases in drilling and well completions, and if development of the petroleum potential of the Caspian region slows.

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Investment requirements for the Soviet oil industry are soaring, primarily because of the aging of key West Siberian oilfields and the need to develop a much larger number of smaller, less productive, and more remote fields. The Soviets appear committed to maintaining oil output at a high level—the 1990 target is 12.7 million b/d. Plan data (expressed in percentages) suggest that Moscow believes investment of roughly 80-85 billion rubles will meet the oil industry's requirements in 1986-90. We estimate, however, that investment will have to be about 100 billion rubles—double the level of 1981-85—to keep oil production from falling below 11-1/4 million b/d.

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Moscow will be unable to compensate for lower-than-expected oil production with cuts in domestic consumption. Despite substantial efforts to reduce domestic use, we expect the regime will be able to count on only a slight decline in oil consumption during this period. The leadership will

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then be confronted with three options, each of which would have some adverse effect on Gorbachev's economic agenda. The inevitable competition between the industrial modernization program and the oil industry for access to scarce supplies of high-quality steel products, equipment, and instrumentation will force hard choices:

- Stimulating oil production through increased purchases of Western oilfield equipment would—barring a turnaround in Moscow's hard currency position—result in cutting imports of machinery and equipment for Gorbachev's modernization program, as well as imports of agricultural products and consumer goods.
- Devoting even more domestic investment to the oil production effort and to the manufacture of oilfield equipment would reduce investment resources for plant construction and equipment in other industries.
- Living with less oil production would substantially reduce hard currency earnings, with direct and indirect adverse consequences for Gorbachev's programs (less Western machinery for the modernization program and fewer high-quality goods for consumption, possibly affecting worker incentive). [redacted]

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The degree to which Moscow will be willing to buy more oilfield equipment from the West is not clear. While Western technology and equipment could reduce (or even prevent) some bottlenecks, we expect that purchases of equipment and technology from the West during 1986-90 will be made on a highly selective basis and at a slower pace than was in prospect before the fall in oil prices. Since late 1985, Moscow has cut back and deferred orders of some equipment and has vigorously pursued efforts to seek lower prices, better financing, and expanded countertrade agreements. [redacted]

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The themes of several of Gorbachev's speeches suggest that he is counting on the revitalization of the Soviet manufacturing industry to improve the general supply and quality of domestic oilfield equipment. From a technological standpoint, Western technology and equipment are not critical for most current Soviet oilfield operations. Much of the oil industry's effort will be concentrated in West Siberia, where tasks of building infrastructure and accelerating the development of new oilfields—while formidable—do not call for sophisticated technology. [redacted]

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In all likelihood, however, Soviet equipment producers will be unable to keep up with the rapidly growing demand for oilfield equipment, increasing the pressure on Moscow to turn to foreign suppliers. Some relief may be available from Eastern Europe, notably from Romania, but purchases from the West remain an option. Soviet buyers are currently engaging a wide range of Western suppliers in discussions for the purchase of oilfield equipment. Although such discussions are not novel, the unusually wide range of suppliers being contacted and the stress on financing terms suggest that the Kremlin is orchestrating its commercial inquiries to extract price and financing concessions. [REDACTED]

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Moscow's willingness to follow up these conversations with actual contracts remains problematical. Proposals to purchase Western oilfield equipment will be competing with requirements of the high-priority industrial modernization program, as well as with equipment needs critical to the coal and natural gas development programs. But the continued heavy need for oil as both a prime energy product and a major source of hard currency will increase pressure on Moscow to spend whatever is necessary to keep oil output above 11 million b/d. Given Soviet hard currency problems, signings of substantial contracts would be a clear signal of the importance attached to maximizing oil production in the short and medium term. (Fortuitously, the current worldwide depression in the oilfield equipment industry will probably reduce the cost and leadtimes for whatever equipment is purchased.) [REDACTED]

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Regardless of the approach taken to cover for domestic production shortfalls, the Soviets will continue to obtain from the West some specialized equipment and technology that they cannot manufacture themselves or acquire from Eastern Europe. Emphasis will be on equipment for offshore operations and on specialized corrosion-resistant equipment and processing plants essential to exploitation of the deep, high-sulfur oil and gas fields of the Pre-Caspian Depression. [REDACTED]

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In all likelihood the leadership will be increasingly frustrated by a growing gap between planned and actual oil production. The industry almost certainly will require more investment than is currently planned. The production outlook is made more complex and volatile by the questionable reliability of Soviet reserve estimates and the uncertain outlook for West Siberian new-well flows, which have fallen rapidly in recent years. If production begins to fall more rapidly, moving Moscow in the direction of

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the worst case scenario, the USSR would stand to lose nearly all revenues from oil exports to hard currency countries and would be forced to make major cuts in oil exports to Eastern Europe. Hard currency is essential to purchase grain, foodstuffs, and other desired imports from the West, and a continuing supply of oil to Eastern Europe is important for maintaining economic and political stability there. We believe that Moscow would devote even more investment to its oil sector in an attempt to forestall such developments. In this circumstance, investment in other parts of the energy sector—as well as in transportation, the modernization program, agro-industry, and perhaps even the military—would be subject to cuts.

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After 1990, Soviet oil production could be in an even more precarious position. National oil output could fall sharply, and the Soviets would need to bring on line substantial capacity from a new oil region, perhaps the Barents Sea. If Moscow elects to expedite development of any offshore field in the Barents, its only realistic option would be to rely on Western technology and equipment. An effort to establish a domestic capability to manufacture offshore arctic equipment would create further bottlenecks in equipment supply and consume already scarce investment resources.

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**Contents**

	<i>Page</i>
Summary	iii
Preface	ix
Soviet Oil: Increasing Costs	1
The Outlook for Soviet Oil Production During 1986-90	2
West Siberia: Centerpiece of the Soviet Oil Industry	4
Plans for Tyumen' Oblast	8
Most Likely Outcome	8
High Case	9
If the Bottom Drops Out	9
Production From Tomsk Oblast	11
Oil Production in Other Regions	12
Implications for the Economy	14
Can Oil Consumption Be Reduced?	14
Responding to the Shortage	16
Will Moscow Increase Imports of Western Equipment and Technology?	16
Can Moscow Afford To Throw More Rubles at Oil?	16
Will Moscow Opt for Lower Oil Production?	18
The Bottom Line	19
 <b>Appendixes</b>	
A.    How Much Investment Is Needed in 1986-90?	21
B.    Prospects for Gas Condensate Production	25



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**Preface**

Forecasting Soviet oil production is a far less exact exercise than forecasting production in the West. Lack of information on important variables—the entire gamut from proved reserves through field development—plays a part. The uncertainty is compounded by lack of evidence as to the strength of Moscow's commitment to attaining planned oil-production targets in the face of inefficiencies and soaring costs that would make Western oilmen and their bankers blanch. Because of these uncertainties, we do not present the usual forecast with confidence bounds. [REDACTED]

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Instead, we present our approximation of the most likely outcome, together with two scenarios on the basis of alternative assumptions relating to the physical aspects of oil production and to the policy choices affecting the outcome. Our "high case" combines positive developments in the field with an assumed willingness of the leadership to commit to oil production substantially more investment and manpower than currently planned—even at the cost of some impairment of other programs. Our "worst case" output projection entails a more-rapid-than-expected deterioration of conditions in the field and a leadership decision to accept the consequences of refusing to pay the steeply escalating costs required to sustain oil output. [REDACTED]

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## Soviet Oil Production Through 1990: Hard Choices Ahead

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### Soviet Oil: Increasing Costs

The Soviet oil industry is one of the oldest in the world. Beginning with hand-dug wells in Baku in the early 1800s, the Soviet industry has risen to first place in world oil output (averaging 11.9 million barrels per day in 1985) while ranking second in oil exports (about 3.4 million b/d).<sup>1</sup> Its rise to preeminence was fueled by rapid output growth during the 1960s and 1970s. [ ]

Before World War II, about 70 percent of Soviet oil production was concentrated around Baku. This phase of Soviet oil development came to an end in the mid-1950s when the industry made both a quantitative and a geographic leap from the modest production levels of Baku to the large, productive oilfields of the Volga-Urals region (see foldout map). Output from the Volga-Urals region, however, peaked in 1975, and by 1980 average annual output fell roughly 200,000 b/d. Fortunately for Moscow, the development of prolific giant and supergiant oilfields in West Siberia allowed national output to show large increases through 1980. [ ]

During the late 1970s and early 1980s, however, West Siberian production became increasingly complicated and expensive. Average flows from new wells fell from over 1,000 b/d in 1975 to 480 b/d in 1980 while investment rose by 75 percent. The rate of growth of Soviet oil production slowed to less than 1 percent per year by 1981-83. In 1984 and 1985, despite intensive efforts to stabilize oil output, national production fell roughly 100,000 and 300,000 b/d, respectively. [ ]

Costs will continue to rise during 1986-90 as the Soviet oil industry deals with three fundamental trends: a growing water cut (proportion of water in the fluid produced from oil wells); escalating drilling requirements; and the need to develop a much larger number of smaller oilfields that are less productive,

<sup>1</sup> Oil production reported by the USSR includes natural gas liquids. Of the total oil exports, roughly 260,000 b/d were acquired by the USSR (primarily in exchange for arms) from Middle Eastern countries and reexported. [ ]

more complicated, and more remote. With increasing numbers of new wells being drilled and old wells "watering out" rapidly because of both aging and waterflooding, the industry's requirements for artificial lift of fluid—and, concomitantly, for well-repair services—will escalate rapidly (figure 1).<sup>2</sup> Also, to keep production in the range of 11-12 million b/d during 1986-90, we estimate that Soviet oilmen will have to perform roughly 190-200 million meters of development drilling—compared with 125 million meters during 1981-85. Because of declining new-well flows, drilling requirements are growing rapidly. In 1990 alone the Soviets will be required to drill about 50 million meters—roughly equal to the total drilling performed in 1976-80. [ ]

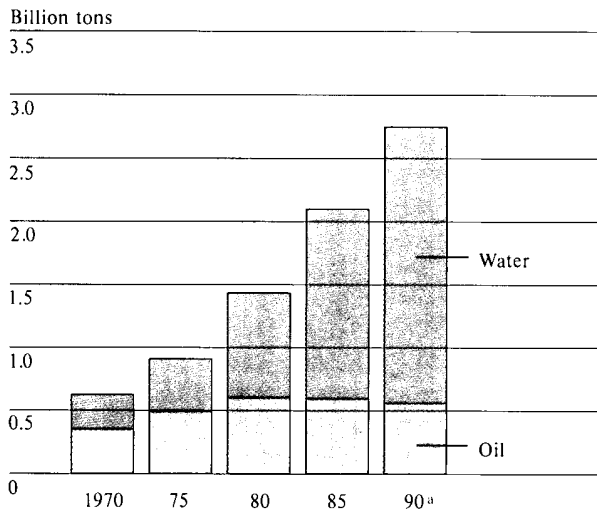
As a result of these factors, investment in the oil industry has risen rapidly in recent five-year plan periods, from about 18 billion rubles during 1971-75 to 29 billion rubles during 1976-80 and to 50 billion rubles during 1981-85. Analysis of past investment trends as a function of drilling, estimated fluid-lift requirements, and major planned inputs already announced for the oil industry leads us to estimate that oil industry investment during 1986-90 will have to double—to about 100 billion rubles—if Moscow is to keep oil production near 11-1/4 million b/d (appendix A).<sup>3</sup> [ ]

<sup>2</sup> The substantial impact of each 1-percentage point change in water cut on total fluid-lift requirements may be illustrated by the Soviet oil industry's experience in 1980. If the average water cut had been 57 percent, as originally planned, the 12.1 million b/d of oil output would have implied a total fluid production of 28.2 million b/d. With the 58-percent water cut in the revised plan, however, the implied production of total fluid for the year amounted to 28.8 million b/d. A 1-percent change in water cut thus implied the lifting of an additional 660,000 b/d of fluid. [ ]

<sup>3</sup> Oil industry investment of 100 billion rubles would represent 10 percent of total Soviet investment during 1986-90; the 50-billion-ruble increment over the first half of the decade would account for 30 percent of the planned increment in investment for the economy as a whole. [ ]

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**Figure 1**  
**USSR: Oil Well Fluid Production, 1970-90**



<sup>a</sup> Estimated.

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Although General Secretary Gorbachev would doubtless prefer to see the oil sector claim a smaller segment of the investment "pie," existing plans for oil production and investment indicate that Moscow—at least for now—will provide the resources necessary to attempt to keep oil production at a high level. Oil industry investment is planned to increase 31 percent in 1986, to almost 15 billion rubles. This steep increase follows an 11-percent hike in 1985. During 1986-90, Moscow plans to increase overall energy investment 35 percent over the 1981-85 investment level. Because of the pressing investment needs of the oil sector and the sharp increase in 1986 investment, we believe that the 35-percent increase in energy investment is not proportionally divided among the energy sectors on the basis of past shares but includes a larger share for oil. In a recent party congress speech, it was reported that planned oil industry investment was increased 10 percent above the preliminary guidelines. We estimate that Moscow is planning to invest roughly 80-85 billion rubles in the oil sector during 1986-90. This level of investment

appears far short of what we estimate is needed to keep production near 12 million b/d, much less to meet the plan of 12.7 million b/d.

Despite the substantial growth in oil production evident so far this year, the Soviet press continues to criticize the industry for little improvement in productivity of oilfield operations. (Soviet economic statistics show that productivity in the oil industry during January-July 1986 was down about 2 percent from last year's level.) Without improvements in labor productivity, Moscow will have to increase the number of personnel working in the oil industry. But attracting additional manpower to work in the oilfields, particularly in West Siberia, will not be easy. Soviet press reports indicate that one West Siberian oilfield construction association annually loses 40 percent of its work force. Gorbachev indicated in his September 1985 speech in West Siberia that the lack of adequate social infrastructure in this region is a major cause of high labor turnover. To attract and retain more workers, Moscow will have to follow through on plans to boost investment for housing and the social infrastructure.

#### The Outlook for Soviet Oil Production During 1986-90

Moscow has targeted production to rise to 12.7 million b/d in 1990, a goal almost unchanged from those set in the two previous five-year plans. Although oil production has picked up to 12.2 million b/d in the first eight months of 1986 (see inset), we believe that the USSR will not be able to sustain this growth. We project that nationwide oil production will begin declining again in 1987 and will reach 11-1/4 million b/d by 1990. Under our "best case" scenario, Moscow would be able to just maintain current production levels of about 12 million b/d through 1990. This would depend upon the Soviets developing a large number of small and remote West Siberian oilfields, reducing the number of idle wells in West Siberia by improving the quality and supply of oilfield equipment, and developing sour oil and gas condensate fields in the Pre-Caspian Depression. Our "worse case" scenario projects a fall in oil production to 10-1/2 million b/d by 1990 (see table 1).

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**Near-Term Outlook for Soviet Oil Production**

**Why Has Output Risen in 1986?** We estimate that Soviet oil production will average about 12.2-12.3 million b/d in 1986. This year's rise has resulted from an increase in Tyumen' output—realized largely by returning idle wells to production, by sharply stepping up the pace of drilling and well completions, and by improving gas-lift operations at the region's two largest oilfields, Samotlor and Fedorovo. In 1986, the increase in drilling in Tyumen' will probably exceed 5 million meters, a sharp increase from the 1983-85 annual increments, which we estimate were in the range of 1-2 million meters. To pay for the increase in drilling and well-repair activities, Moscow is increasing investment in the oil sector by 31 percent in 1986. Comparison of overall investment and drilling activity in Tyumen' for 1984 and for 1986 suggests that the investment cost per meter of drilling in Tyumen' has remained level or has risen slightly. Further increases in drilling will require at least proportionate increases in investment. [ ]

**Outlook for 1987.** The tasks facing the Soviet oil industry next year will be more formidable. The press reports that most of the idle wells returned to production in 1986 required only minor repairs and that it will be more difficult to bring back on line the remaining idle wells. As the percentage of wells awaiting repair or pumps is reduced to a normal level, the burden of providing oil to offset depletion will fall increasingly on development drilling and the commissioning of new wells. The preparation of new drilling sites will entail substantial construction work to provide new well pads, powerlines, and other production-related infrastructure. [ ]

Moscow may be able to sustain some growth in production in 1987 with a continued heavy commitment of investment. However, as the increase in the number of wells coming on line slows and the repair requirements for maintaining an ever-increasing number of wells escalate, production will eventually level off and begin to decline before the end of the year. [ ]

**Table 1**

Million barrels per day

**Alternative Estimates of Soviet Oil Production in 1990 <sup>a</sup>**

	Most Likely Case	High Case	Worst Case
USSR total	11.25	12.1	10.5
West Siberia	7.35	7.97	6.83
Tyumen'	7.05	7.65	6.55
Tomsk	0.30	0.32	0.28
Other regions <sup>b</sup>	3.90	4.10	3.70

<sup>a</sup> The estimates for Tyumen' output are derived in table 2; for Tomsk, from the current production level and extrapolation of past trends; and for other regions, from decline-curve analysis.

<sup>b</sup> Includes gas condensate production from the North Tyumen' gasfields.

To increase oil output, we believe the Soviets would need to discover and develop a supergiant or several giant oilfields. Any substantial impact on production, even if such a field or fields were to be discovered tomorrow, would be highly unlikely in the 1986-90 period because of the leadtime necessary for development. There is some potential for discoveries of giant oilfields in the Barents Sea, but significant production from any field in that region is unlikely to commence before 1990 (see inset). [ ]

To provide the foundation for these estimates, we first examine the outlook for West Siberia. Despite the growing production difficulties there, the leadership is reportedly planning to increase dependence on West Siberian production from the current level of 60 percent of nationwide oil production to 70 percent by 1990. [ ]

[ ] We then review the situation in the other oil regions, where prospects are dominated by factors affecting the rate of decline of production in the Volga-Urals region. [ ]

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### *Oil Potential of the Barents Sea<sup>a</sup>*

*The acceleration of Soviet exploration in the Barents Sea during the last two to three years suggests that Moscow is engaged in a determined effort to assess the sea's oil potential. The draft guidelines of the 12th Five-Year Plan (1986-90) call for the development of the oil resources of the USSR's continental shelf. Although not stated explicitly, we take this to mean that the Soviets will begin to develop the oil resources of the Barents Sea during this period. Even so, in view of the long leadtimes involved (10 to 15 years for major offshore development), Barents Sea oil will not have much of an impact on the Soviet energy picture until the 1990s.*

*Our analysis of Soviet technical literature* [redacted] *suggests that massive amounts of potentially recoverable oil (25-30 billion barrels) exist in the Soviet portion of the Barents Sea. While the indicators point to large potential resources, however, we do not have information on the size of the individual reservoirs that may exist. During the last*

*several years a significant number of seismic and regional aeromagnetic surveys, as well as shipborne gravimetric, bottom-sounding, and sampling studies, have been conducted. A number of wells have been drilled and several gas strikes and one oil strike have been made.* [redacted]

*The Barents Sea poses formidable challenges to any oil development effort. Storms, high seas, fog, snow, and—in some areas—pack ice hamper exploration and will increase the difficulty of maintaining drilling and pumping equipment. Most of the exploration activity has been concentrated in the southern portion of the sea in fairly shallow water (100 to 250 meters), and the Soviets would almost certainly develop this area first. Even under the best of conditions, this would entail an effort far offshore in arctic waters on a scale never before attempted by the Soviets. Nevertheless, we see nothing that would make the development of southern Barents Sea oil technologically impossible. Producers in the North Sea have been operating for years in conditions no worse than those in the Barents Sea.* [redacted]

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### **West Siberia: Centerpiece of the Soviet Oil Industry**

West Siberia has been the source of increased oil production for about a decade, with annual production in 1971-80 growing at an average annual rate of 25 percent; in some years the increment exceeded 600,000 b/d (see figure 2). The ease of achieving this rapid growth led many officials to believe that West Siberian output would ultimately reach 10 million b/d. A false sense of security engendered by past successes—which is partly responsible for many of the region's current problems—has yet to be fully dissipated. [redacted]

During the period of rapid production growth, exploratory drilling came to be regarded as a high-cost operating expense that could be eliminated because of a large "identified," albeit untapped, reserve base. Exploration drilling in the USSR stagnated and, by 1980, was equal to only 30 percent of the volume of

development drilling in West Siberia (figure 3). Unfortunately for the Soviets, their exploration efforts failed to discover new giant, highly productive deposits, and developed oil reserves were being depleted faster than they could be replaced by the smaller fields that were being proved. [redacted]

With West Siberian oil production largely dependent on output from a small number of aging oilfields, oil policy relating to West Siberia was at a critical juncture during the late 1970s. Maximizing production over the long term would have required Moscow to (1) slow the growth in production from existing fields in order to improve prospects for ultimate recovery and (2) sharply increase the exploration effort while simultaneously developing infrastructure

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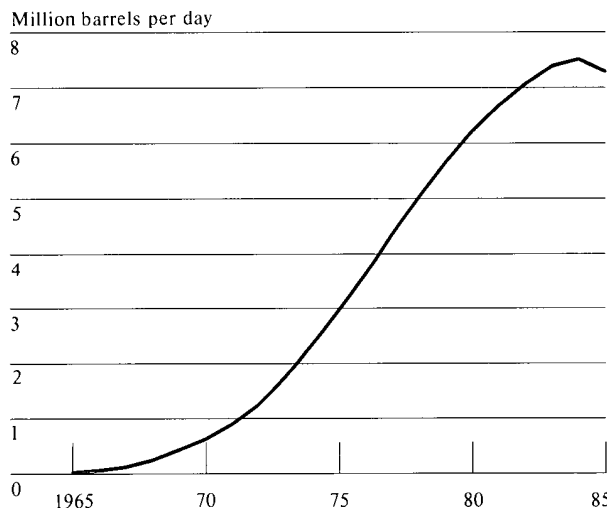
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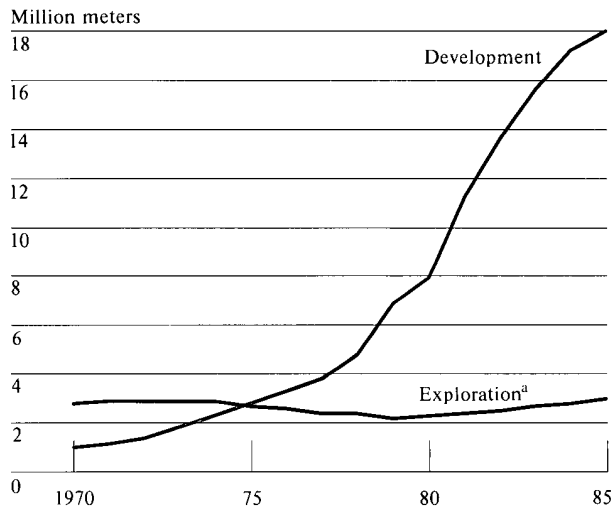


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**Figure 2**  
**USSR: Oil Production in**  
**West Siberia, 1965-85**



**Figure 3**  
**West Siberia: Development Versus**  
**Exploration Drilling, 1970-85**



<sup>a</sup> Including exploration drilling in other regions.

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for bringing more of the smaller fields on line. The Soviets, however, took the opposite approach. Output from existing fields was maximized with little effort to step up exploration or bring more of the smaller fields on line. We believe that they chose this course of action for several reasons:

- Accelerating oil production at the established fields was relatively easy and inexpensive with a quick payback.
- Maintaining growth in oil production at a time when faster-than-expected production declines were occurring in regions outside West Siberia was important for national prestige.
- High-priced oil was an attractive export earner at a time when the Brezhnev regime was counting on Western equipment and technology to improve the industrial base and Western foodstuffs to back Brezhnev's commitment to better the consumer diet.

- Reserve estimates provided by the geologists appeared more than adequate to permit further growth of production in West Siberia.
- Using oil allowed Moscow to meet easily the rapidly growing energy demand and to pursue faster industrial growth with only modest additional conversion and infrastructure costs.

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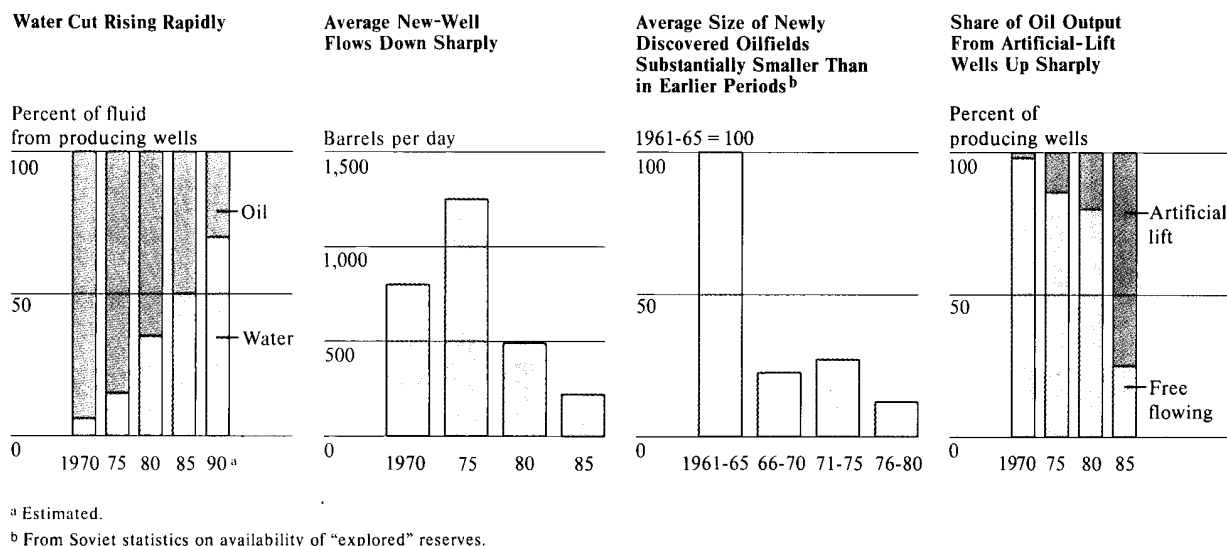
Despite large increases in the volume of drilling and in the number of oil wells brought on line, growth in production slowed considerably during the early 1980s (see inset and figure 4). In 1983, West Siberia's oilmen failed for the first time to reach the planned production goal. In 1984, regional production rose less than 150,000 b/d. Despite this poor performance, the 1985 plan called for substantial growth—to about 8 million b/d. However, West Siberia's 1985 output fell

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**Figure 4**  
**Key Trends Affecting Tyumen' Oil Production**

Note scale change



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### ***Has West Siberia Seen Its Heyday?***

*West Siberia is by any standard a mature oil-producing region. Because output from most of the best oilfields has peaked, overall production capacity remains virtually level even though the Soviets are adding wells from less productive fields at increasing rates (so far in 1986, about 40 percent above last year's pace). At a comparable age, the Volga-Urals region experienced peak output, which has been followed by an irreversible decline. Although such an outcome in the near term is not a foregone conclusion for West Siberia, the era of "easy oil" has certainly come to an end. There are more wells to drill; more pumps to install and maintain; more water to pump, separate, and reinject; and more fields to develop in the attempt to sustain West Siberian oil production.*

*Developments associated with the aging of Samotlor, the USSR's largest oilfield, were the principal cause for last year's decline in West Siberian oil output. Moreover, the "Samotlor disease"—a vicious circle of flagging output from giant oilfields and ever-increasing use of manpower and equipment in an attempt to sustain total oil output—is spreading throughout the West Siberian oil region. At various times in 1985, as many as one-third of Samotlor's wells were idle. The high number of inactive wells was caused by unreliable pumping equipment and shortages of well-repair brigades. The high water content, in turn, causes additional complications (more corrosion of piping and equipment, and more need for storage facilities and separation equipment to handle the water) that boost both the labor and capital intensity of the oil-production effort.*

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short of the 1984 production level by 240,000 b/d. Until 1984, West Siberia's annual increments more than offset all the regional declines elsewhere in the USSR. The 1985 decline in West Siberian output was chiefly responsible for national output dropping 300,000 b/d (see figure 5). [ ]

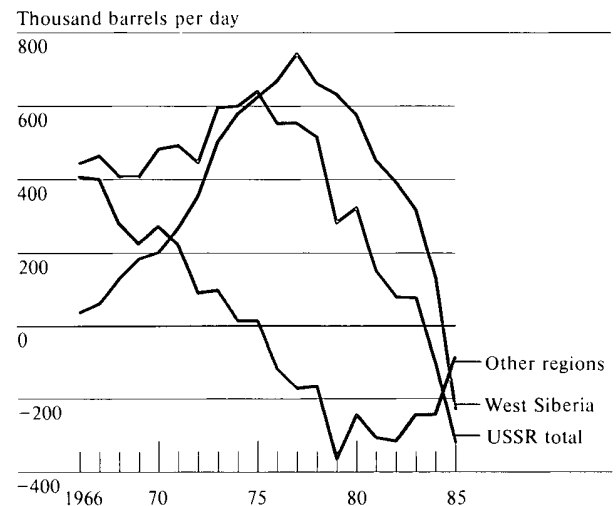
Growing Kremlin concern about problems with oil-production operations in Tyumen' Oblast—which accounts for about 96 percent of West Siberian output—came to a head in 1985.<sup>4</sup> Despite the replacement of the oil minister, the head of Tyumen' oil operations, and numerous other local oil industry and party officials, Gorbachev observed little or no improvement in the performance of Tyumen' oil operations from February through late August 1985. In early September 1985, he traveled to Tyumen' on a personal factfinding mission. Gorbachev—indicating that no quick solutions to the region's oil problems were at hand—criticized Tyumen' party and industry officials for failing to develop enough new oil deposits and for inadequately preparing for the transition from the era of "golden gushers" to the era of forced extraction by artificial lift. [ ]

Gorbachev also noted that West Siberia's explored reserves had declined steadily over the past decade and that the region's current ratio of reserves to production (reserves expressed as a multiple of 1984 oil output) was down to the nationwide average for the oil industry. He also indicated that past decisions had substantially reduced the potential for raising output at Tyumen' as planned. [ ]

There are no easy options available to boost oil production. Active and persevering high-level intervention will be necessary to ensure that the oilfield equipment industries are able to increase the supply of equipment. Tightened labor discipline and better management could lead to more efficient oilfield operations. Nonetheless, because of the confluence of several negative factors affecting Tyumen' output, the Soviets will have to work efficiently and hard just to minimize production declines during 1986-90:

<sup>4</sup> Tyumen' Oblast lies west of the Ural Mountains and comprises most of West Siberia, including the Middle Ob' region where the oilfields are concentrated—among them the supergiant Samotlor oilfield (one of the world's largest). [ ]

**Figure 5**  
**USSR: Year-to-Year Change in**  
**Oil Production, 1966-85**



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- Production is overly dependent on output from a dozen giant, now aging oilfields that were developed during the late 1960s and early-to-middle 1970s. Soviet geologists no longer expect the discovery of a "second Samotlor."
- New capacity will have to come from expanding development northward and exploiting 60 to 75 remote fields (compared with 13 new field commissionings during 1981-85) that are smaller, more complicated structurally, and far less productive than the oilfields developed up to 1980.
- Average flow from new wells has steadily declined—from 1,250 b/d in 1975 to 490 b/d in 1980 and to about 220 b/d in 1985—and is still headed downward.

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- Technically inappropriate water injection practices and excessive infill drilling have caused the share of water produced with oil to rise to 50 percent, increasing the demand for reliable pumping equipment.<sup>5</sup> By early 1986, about 80 percent of the producing wells were operating with artificial-lift equipment. Maintaining consistent production operations will be much more difficult than in the past because six out of seven new wells in Tyumen' require pumps from the onset of production. Not only shortages of equipment but also a long history of unreliability of Soviet pumps make it almost certain that maintenance requirements will be severe, and servicing problems will be aggravated by the harsh climate and remoteness of the West Siberian region.

- The infrastructure (water injection facilities, oil treatment facilities, gathering pipelines, storage tanks, roads, and electric powerlines) in Tyumen' is reportedly four to five years behind the level needed to support efficiently the current production effort. Moreover, much of the oil-producing infrastructure is being weakened by corrosion. [ ]

**Plans for Tyumen' Oblast.** Press reports indicate that the Soviets have endorsed a plan to produce about 8.4 million b/d of oil in Tyumen' in 1990—well over 1 million b/d above the level of 7.1-7.2 million b/d we estimate for 1985. The Soviet press has also reported plans to double the number of existing wells and to double the amount of development drilling over that achieved during 1981-85. These reported plans imply that Gorbachev is not altering the thrust of oil production policy for Tyumen' during 1986-90 and is continuing to emphasize production growth despite the high and rising cost. The planned 1.3 million-b/d increment over 1985 output is about as large as the increment posted during 1981-84. Given the existing state of affairs in Tyumen', the current plans are more ambitious and less likely to be realized than any in the past. [ ]

<sup>5</sup> Infill drilling is the practice of drilling new wells between existing wells and, thereby, reducing the well spacing. This practice increases oil production in the short term but reduces reservoir pressure and shortens the average life of the wells in an oilfield. [ ]

**Most Likely Outcome.** Our best judgment is that output from Tyumen' will increase in 1986 and then fall slowly to roughly 7 million b/d by 1990, despite an enormous effort to raise production and some success in improving management and the quality of materials and equipment:

- We judge that Tyumen' oilmen will probably meet—but not exceed—the well-drilling plan. Exceeding the development drilling targets during 1986-90 will be more difficult than in the past, not only because of the huge increase in drilling called for but also because the drilling effort will be spread over a larger number of fields in remote areas lacking infrastructure. The producing horizons in the new fields are deeper, a factor that will slow the drilling effort.<sup>6</sup>
- We believe that the Soviets will have difficulty maintaining 85 percent of their wells in active status—especially during a period when the total well inventory will probably double. The Soviet press reports that the number of well-repair brigades will also increase by roughly 50 percent during 1986-90, but press reports and analysis of the activities of these brigades show little, if any, improvement in their productivity.
- The need to proceed with existing but lagging infrastructure development programs and to cope with intensifying corrosion problems that are damaging older production-support facilities will drain material and labor resources away from the effort to bring new fields on line. We judge it unlikely that Tyumen' oilmen will be able to bring on line 75 new fields planned for introduction during 1986-90. During 1981-85, the Soviets introduced only 13 of

<sup>6</sup> Many of the producing horizons in fields currently being brought on line are below 3,000 meters. The efficiency—measured in meters drilled per rig per month—of Soviet turbodrills drops about 30 percent at depths greater than 3,000 meters because of the progressive loss in pressure of the fluid that operates the turbine. The average well depth in Tyumen' has been increasing—from about 2,200 meters in 1975 to about 2,600 meters in 1985—and we estimate that the average depth will be about 2,800 meters in 1990. [ ]

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26 fields scheduled. The Soviet press called for an accelerated effort in 1985, but later reported that fields were still being brought on line too slowly due to infrastructure constraints. During January-June 1985, Tyumen' oilmen met only 5 percent of the plan for production from new fields.

- We believe that the Soviet oilfield equipment industries will be hard pressed just to supply the necessary increases in equipment. Soviet press reports indicate that key plants in the Baku region are already operating near capacity. It is unlikely that the oilfield equipment industries can effect a marked improvement in quality while engaged in an all-out effort to increase the volume of equipment produced. [ ]

Table 2 illustrates the assumptions and implications of this projection as well as those of the following cases. [ ]

**High Case.** In our judgment, the best possible outcome for Moscow from a forced-draft effort would be to stabilize Tyumen' production at approximately 7.6 million b/d. Soviet oilfield-equipment industries would also have to improve markedly both the quality and quantity of equipment supplied (see inset). To stabilize output at this high level, the following would have to occur:

- The plan for development drilling would have to be exceeded and roughly 38,500 new production wells brought on line (nearly all will require pumping equipment)—more than double the number of wells brought on line during 1981-85.
- The Soviets would have to establish a capability—by increasing the reliability of their pumping equipment and improving their ability to service and repair wells—to keep almost 90 percent of their well inventory active. (In contrast, according to the Soviet press, during mid-1985 Tyumen' oilmen were able to keep only about 80 percent of the production wells active.)
- Tyumen' oilmen would have to equip and bring on line at least 75 new oilfields during 1986-90—roughly six times as many new oilfields as were introduced during 1981-85. [ ]

The incremental investment requirements for this result could amount to 15 billion rubles. With investment tight in the energy sector as well as in the economy as a whole, a decision to provide such an amount and sacrifice other important plan targets would most likely stem from a pressing need to earn hard currency. [ ]

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**If the Bottom Drops Out.** There is a chance that the pace of drilling will stabilize rather than increase due to factors such as shortages of drilling and well-completion equipment, lack of production infrastructure (particularly well pads) in new fields, and diminishing opportunities to conduct infill drilling at the established fields. In this circumstance, oil production could fall sharply by 1990. [ ]

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The huge increase in drilling during 1981-85, together with the slow pace at which new fields were brought on line, points to substantial infill drilling during the period. Nearly all of the major fields are at least 10 years old and have probably been drilled extensively. While we do not know the actual extent to which infill drilling is becoming impractical at the older fields, Tyumen' oilmen could, in the near term, face a situation in which the bulk of planned development drilling would have to be concentrated in smaller new fields.<sup>7</sup> [ ]

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Tyumen' oilmen claim that central planners do not understand the seriousness of the situation. Investment allocations for new field development are reportedly inadequate because funds are being allocated on the basis of costs encountered in earlier field development and are not taking into account the rapidly escalating costs associated with development of the more remote and smaller fields.<sup>8</sup> Inadequate field

<sup>7</sup> Press reports indicate that the increased pace of drilling evident so far in 1986 is rapidly reducing the number of prepared well pads available for drilling, particularly at new fields. [ ]

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<sup>8</sup> Even with large investment allocations, new field development will proceed slowly at first. Before field production can begin to grow, field infrastructure—well pads, storage tanks, oil separation facilities, electric transmission lines, and gathering pipelines—must be in place. Creating this infrastructure is a time-consuming process made more difficult not only because of the crisscrossed lines of responsibility in the bureaucracy but also by the severe northern climate and swampy terrain that is often impassable except in winter. [ ]

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**Table 2**  
**Estimates of Oil Production in Tyumen' Oblast**

Most Likely Case					
Calculation of Capacity Added (Based on 14-Percent Depletion Rate) <sup>a</sup>	1986	1987	1988	1989	1990
Wells added	6,400	6,700	7,000	7,300	7,600
Average new-well flow ( <i>barrels per day</i> )	204	190	175	160	150
Capacity added ( <i>million b/d</i> )	1.306	1.273	1.225	1.168	1.14
Percent remaining in 1990	0.547	0.636	0.740	0.860	1.000
Capacity remaining in 1990 ( <i>million b/d</i> )	0.714	0.810	0.906	1.004	0.570
Net capacity added, 1986-90	4.004				
<b>The Estimates</b>					
1985 capacity ( <i>million b/d</i> )	8.7				
Depleted by 1990 ( <i>million b/d</i> )	- 4.6				
Net capacity added, 1986-90 ( <i>million b/d</i> )	4.0				
1990 total capacity ( <i>million b/d</i> )	8.1				
Share utilized	0.87				
1990 oil production ( <i>million b/d</i> )	7.05				
Assumptions	<ul style="list-style-type: none"><li>• Drilling plan is met.</li><li>• Share of well inventory in active status remains at mid-1986 level of roughly 87 percent.</li><li>• New field development accelerates but falls short of plan.</li><li>• Equipment supply increases but quality remains a problem.</li><li>• Moscow provides investment in the range of 95-100 billion rubles.</li></ul>				

<sup>a</sup> We believe that our production estimates fairly represent the range of possibilities as to how many wells the Soviets could add during 1986-90 and what share of the well inventory they can maintain in active status. The estimates, however, are particularly sensitive to two key variables that were projected on the basis of

past trends: the depletion rate and new-well flows. An increase in the depletion rate of 1 percent decreases the 1990 production estimate by roughly 300,000 b/d. Also, an increment of 10 b/d in 1990 new-well flows would raise the production estimate about 100,000 b/d.

infrastructure would constrain development drilling, and the full impact of declining well flows would be reflected in the region's oil output. Under these circumstances, Tyumen' output could fall to about 6.5 million b/d by 1990.

The "worst case" scenario—with its assumption of limited investment funding—presumes that Moscow would be willing to suffer the implicit negative consequences for its hard currency revenues and for support

of the East European economies in order to protect priority programs elsewhere in the economy. Such a decision would be contrary to the leadership's reaction to past crises in oil production, when heroic measures were adopted to provide manpower and equipment. But in 1986-90, the costs of extraordinary measures will be escalating from already high levels. In a

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**Table 2 (continued)**

High Case					Worst Case				
1986	1987	1988	1989	1990	1986	1987	1988	1989	1990
6,500	7,100	7,700	8,300	8,900	6,400	6,550	6,700	6,850	6,900
204	190	175	160	150	204	190	175	160	150
1.326	1.349	1.347	1.328	1.335	1.306	1.245	1.172	1.096	1.035
0.547	0.636	0.740	0.860	1.000	0.547	0.636	0.740	0.860	1.000
0.725	0.858	0.997	1.142	0.668	0.714	0.792	0.867	0.943	0.518
4.390					3.833				
8.7					8.7				
-4.6					-4.6				
4.4					3.8				
8.5					7.9				
0.90					0.83				
7.65					6.55				
<ul style="list-style-type: none"> <li>• Drilling plan is exceeded.</li> <li>• Share of well inventory in active status increases to 90 percent.</li> <li>• New field development accelerates and exceeds or meets plan.</li> <li>• Equipment supply and quality improve markedly.</li> <li>• Day-to-day operations improve through better management; as a result, drilling productivities increase, the quality of well repairs improves, and new field development is smoother and on schedule.</li> <li>• Moscow provides about 125 billion rubles (about 50 percent more than planned), probably impairing programs elsewhere in the energy sector or in the economy.</li> </ul>					<ul style="list-style-type: none"> <li>• Drilling is constrained; plan is underfulfilled.</li> <li>• Share of well inventory in active status falls to 83 percent because of low reliability of equipment.</li> <li>• New field development is slow.</li> <li>• In 1988-89, Moscow decides against continuing large annual investment increases, and total investment for 1986-90 is held down to 80 billion rubles or somewhat less. Moscow accepts low oil production, along with its negative consequences for hard currency revenue and support of East European economies, in order to protect priority programs elsewhere in the economy.</li> </ul>				

situation where other major programs in the economy (such as modernization of industry and agriculture) might encounter substantial obstacles and require a greater infusion of investment, Moscow's analysis of the trade-offs might lead to acceptance of the lower level of oil production.

**Production From Tomsk Oblast.** The remaining 4 percent of West Siberia's oil production comes from Tomsk Oblast. Production from Tomsk began in 1966

at fields just south of Nizhnevartovsk and has grown slowly. During the late 1970s, production from more remote fields near Novyy Vasyugan came on line. In 1985, output was 260,000 b/d—60,000 b/d more than in 1980. The Soviet press reports a 1990 production plan for Tomsk of 310,000 to 320,000 b/d. We

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***The Quality of Soviet Oilfield Equipment:  
Speaking for Itself***

*In the past, Soviet oilfield equipment served most needs only because the oilmen's sheer persistence compensated for many shortcomings in quality. Recently, however, the volume of equipment being made available to the oil industry has become increasingly inadequate in relation to needs. Moreover, oil production at Tyumen' has entered an era in which sustaining production is becoming critically dependent on the availability of better quality equipment. More efficient drilling and production of fluid from oil wells are needed to offset the impact on production of deeper drilling, lower natural well flows, and higher water cuts. As the record demonstrates, much remains to be done by Soviet manufacturing industries if they are to provide the requisite equipment:*

- *During a 1984 survey of the quality of oilfield equipment produced in Baku, the following was reported: Every second piece of equipment used for well-repair work was delivered from the factory with "serious defects." Every fifth well-completion unit was found defective.*
- *A leading Soviet economic journal reported that the electric cable for submersible pumps is designed poorly and "often" does not work "the first time" the pump and cable are lowered into the well. By November 1985, defective cable was responsible for idling more than 400 wells, and 3,000 kilometers of defective cable had accumulated in the Tyumen' oil-producing region.*

- *In response to a question about the quality of well casing from the Sumgait pipe plant, a driller answered, "We just do not need it" and then elaborated that the casing, which must withstand 200 atmospheres of pressure, sometimes fails at 17 atmospheres.*
- *After an "authoritative commission" recommended a special inhibitor to fight pipeline corrosion, the pipes corroded as before—"because the inhibitor does not inhibit."*
- *Responding to a question on what had changed in the 18 months since a meeting in Baku that focused on the low quality of oilfield equipment, the chief mechanic for Tyumen' oil operations answered, "The amount of substandard output of certain types of equipment produced by Baku plants has even increased."*
- *Construction of one compressor station (of a planned 12) for the Samotlor gas-lift project was "completed" in 1984. However, in November 1985 it was still "impossible to effectively use the station because of the low quality of the equipment."*

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believe that production from Tomsk is likely to continue to grow—but at a slower pace—to roughly 300,000 b/d in 1990. In the second half of this decade, the Soviets are planning to develop oilfields in the Pudino area. Development of the new fields will probably be constrained by the extremely swampy terrain of the Pudino region and the 3,500- to 4,000-meter depth of the producing strata.

**Oil Production in Other Regions**

Established trends make the oil-production outlook less uncertain for other areas. Although oil and gas condensate output outside West Siberia (including gas condensate from the north Tyumen' gasfields) has been falling for a decade—from 6.9 million b/d in

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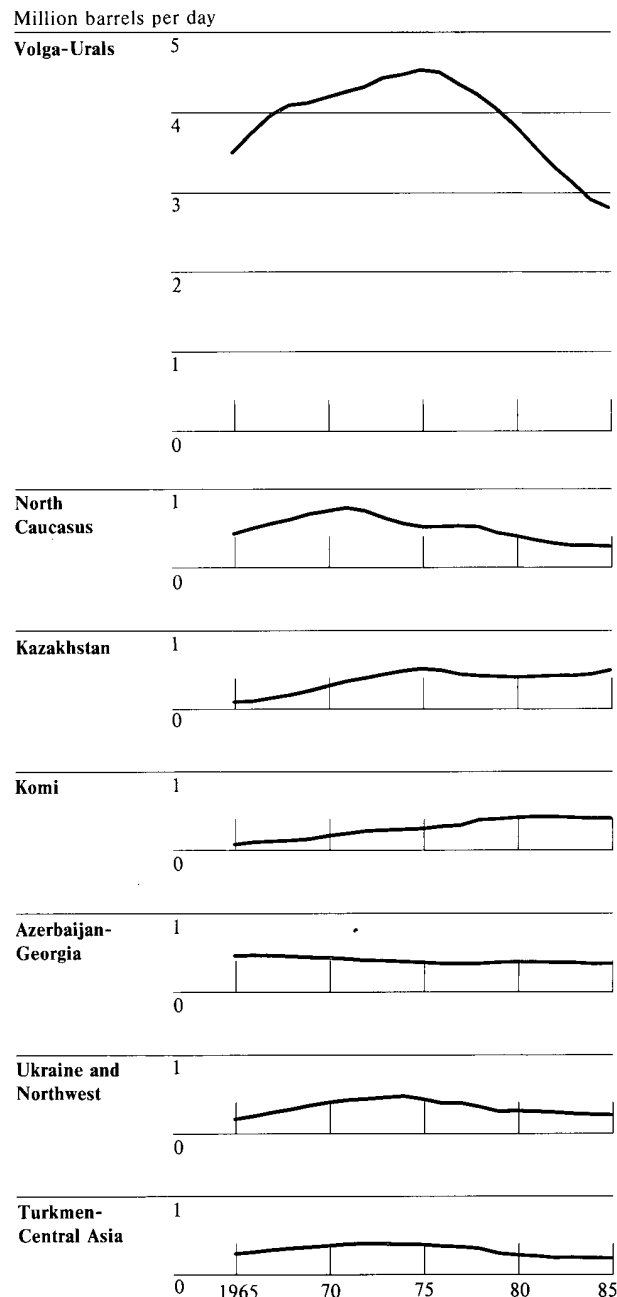
1975 to 4.6 million b/d in 1985—the rate of decline has slowed in recent years. Production from new capacity at oilfields in Kazakhstan and the Caspian Sea is helping to offset declining output from the Volga-Urals region, the USSR's second largest, where production has fallen from about 4.5 million b/d in 1975 to roughly 2.8 million b/d in 1985 (figure 6).

Soviet media suggest that the average annual declines in production for the Volga-Urals region have slowed slightly in recent years. Nonetheless, there is virtually no chance that the Soviets can completely stem the fall in output. Production from the two major fields in this region—Romashkino and Arlan—peaked in the early 1970s. We estimate that the Soviets have already produced about 80 percent of the recoverable reserves (calculated on the basis of a 35-percent recovery factor) for these two fields. Soviet efforts to employ enhanced oil recovery techniques during 1986-90 will probably meet with only limited success, largely because of severe shortages of the needed chemicals. A new group of oil deposits has been discovered near Orenburg, but the depth of the producing horizons (4,400 to 4,800 meters) will probably slow development. The Soviets plan to produce only 50,000 b/d from these fields in 1990.

Our best judgment is that the collective oil and gas condensate output from regions outside West Siberia (including gas condensate production from the north Tyumen' gasfields) will experience an average annual decline of roughly 140,000 b/d during 1986-90. The rate of decline in production from the Volga-Urals region probably will decrease slightly—to about 170,000 b/d annually (less than the average annual decline of 200,000 b/d during 1981-85). The combined oil output from other regions will probably change little as new oil capacity from the Caspian Sea and Kazakhstan comes on line and offsets declining production from the North Caucasus, Central Asian, and Komi ASSR regions.<sup>9</sup> We estimate that condensate output will grow only slowly—by about 30,000

<sup>9</sup> Analysis of the complex geology of Eastern Siberia suggests that the Soviets have so far discovered only limited oil reserves there (roughly 100 million to 1 billion barrels of proved reserves). Because of the distance to industrialized centers, the complexity of the reservoirs, the quality of the oil found so far, and the severe climate and terrain, it is doubtful that the Soviets will mount any major effort to develop East Siberian oil in the period under consideration even if somewhat more substantial discoveries are made.

**Figure 6**  
**USSR: Oil Production**  
**Outside West Siberia, 1965-85**



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b/d annually—during 1986-90 despite the potential for substantial increases in condensate production and numerous press statements emphasizing its importance to the national economy (see appendix B). [ ]

Our assumptions for this most likely scenario are that:

- Declines in output from the Volga-Urals region slow only marginally.
- Implementation of enhanced oil recovery (EOR) techniques at key fields in this region is slow and on a small scale.
- The existing pace of heavy-oil development in Kazakhstan does not increase. Also, the pace of Caspian Sea development slows as output from the April 28 oilfield reaches peak production and development of oilfields in deeper waters and deep gas condensate fields is constrained by shortcomings of domestic equipment. [ ]

We believe that, under the best of circumstances, the Soviets could limit the average annual decline in the level of production outside West Siberia to about 100,000 b/d; alternatively, it could be as much as 180,000 b/d:

- For the high case, we assume the Soviets sharply increase purchases from the West of advanced drilling, production, and processing equipment to accelerate development of the oil and gas condensate potential of the Pre-Caspian Depression. Also, the Soviets purchase and effectively utilize Western EOR technology for use in the Volga-Urals and Komi ASSR regions.
- For the low case, we assume that production declines from areas where output is falling continue (Volga-Urals, Komi ASSR, North Caucasus, and Central Asia), and new capacity is introduced slowly (Caspian Sea and Kazakhstan). This could occur as a result of the continued transfer of equipment and labor resources from these regions to West Siberia (a practice that Moscow has followed to boost production in West Siberia). [ ]

### Implications for the Economy

In all likelihood the leadership will be increasingly frustrated by a growing gap between planned and actual oil production. The success of efforts to improve the flow of needed equipment and to provide better management of the existing stock of wells will, of course, affect the size and timing of the gap. But it will soon become clear that the additional resources Gorbachev has allocated to the industry are not enough and that even additional domestic resources may not solve the problem. How the leadership reacts to this dilemma will be shaped by the following considerations:

- Success in oil conservation and gas-for-oil substitution.
- The ability to cope with a reduction in hard currency imports resulting from cutbacks in oil exports.
- The world market price for oil.
- The ability and will to reduce oil exports to soft currency customers, principally Eastern Europe.
- The need to maintain or increase investment allocations to support key sectors of the modernization program.
- Moscow's perception of its ability to quickly discover and develop the oil potential of the Barents Sea.

### Can Oil Consumption Be Reduced?

An alternative to the production-oriented policy would be a successful oil conservation and substitution program. Success in this area would allow lower production without a proportional reduction of export availability. The high production targets and the enormous increase in investment incorporated in the recently approved annual and five-year plans suggest, however, that Moscow is not confident that substantial oil savings will be realized. We believe that total oil consumption will probably decline only slightly during 1986-90. [ ]

In the last five years, the Soviets have apparently been able to slow and essentially stabilize domestic oil consumption (table 3). As oil and coal output stagnated, the Soviets rapidly boosted gas production and,

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**Table 3** *Million barrels per day*  
**USSR: Apparent Oil Consumption<sup>a</sup>**

	Production <sup>b</sup>	+ Imports <sup>c</sup>	- Exports	= Apparent Consumption
1970	7.06	0.09	1.92	5.23
1975	9.82	0.15	2.61	7.36
1980	12.03	0.08	3.28	8.83
1981	12.18	0.09	3.22	9.05
1982	12.25	0.15	3.39	9.01
1983	12.33	0.24	3.67	8.90
1984	12.22	0.29	3.67	8.84
1985	11.9	0.26	3.37	8.79

<sup>a</sup> The absence of extensive data prevents a close determination of Soviet oil consumption. We can, however, calculate apparent domestic oil consumption by adding exports and subtracting imports from production. The major weakness of this approach is that the change in oil stocks (oil in storage) is not known or included; moreover, the trade data may contain errors. Nonetheless, we believe that apparent domestic consumption can be used as a general guideline for establishing trends—especially when comparing one set of years to another.

<sup>b</sup> Including gas condensate.

<sup>c</sup> Middle Eastern oil is acquired in exchange for arms and reexported by the USSR.

thus, provided the needed energy. Infrastructure to transport and utilize larger supplies of natural gas was put in place. Despite these achievements, during 1981-85 Moscow did not decrease the volume of fuel oil consumed by thermal power plants—which was to have been the main thrust of the effort to conserve oil. Our analysis indicates that the volume of fuel oil consumed by power plants remained at nearly the same level in 1985 as in 1981—about 2.5 million b/d, accounting for about 28 percent of total apparent oil consumption.

Despite successes in substituting natural gas for fuel oil at many power plants, fuel oil consumption by coal-fired power plants increased during 1981-85 because of the lack of an adequate supply of coal (both in terms of quality and quantity) and because of demands on thermal power plant capacity resulting from delays in commissionings of nuclear power plants. These developments offset the oil savings being

realized from the oil-to-gas conversion program.<sup>10</sup> A Soviet technical journal recently reported that 11 percent of the fuel used by power plants designed to burn coal as the primary fuel is fuel oil—compared with about 1 percent for coal-fired plants in the United States.

The USSR's relatively heavy reliance on residual fuel oil for power generation in part reflects the design of its refineries, which use mainly distillation processes that yield a large amount of residual fuel oil suitable only for industrial furnaces. In the past decade at least, the USSR has increased only slightly the share of light products refined from crude oil. For the next several years, large supplies of residual fuel oil will be available, and there will be little incentive to accelerate the conversion of oil-fired power plants.

Of the major oil products (gasoline, kerosene/jet fuel, diesel fuel, fuel oils, and lubricants), we judge that the only one for which there exists an opportunity—either through improvements in efficiency or interfuel substitution—for less consumption is heavy fuel oil:<sup>11</sup>

- The demand for oil products, particularly gasoline and diesel fuel, in transportation and agriculture will probably grow.
- The requirements for nonenergy oil products—such as lubricants and plastics—will probably remain constant or increase.
- Despite the conversion of some plants to gas, the use of fuel oil in the electric power industry, which accounts for about 70 percent of fuel oil consumption, will probably decline by only about 10 percent by 1990 because of continuing problems with low-quality coal and coal shortages.

<sup>11</sup> Soviet press reports indicate that, in 1986, the USSR plans to save about 1.2 million tons of gasoline—about 2 percent of current gasoline production—by using liquefied compressed gas to power about 100,000 automobiles. Demand for gasoline because of new automobile production—about 1.3 million vehicles annually—will easily offset these gains even if they materialize.

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**Responding to the Shortage**

Because the Soviets are likely to fall far short of meeting their oil production targets, the inability to reduce consumption will confront the leadership with essentially three options, all of which will require hard choices:

- Buy a large volume of Western equipment in an effort to boost oil production at the expense of imports for other sectors.
- Devote even more investment resources to the oil industry.
- Live with less oil production and accept reductions in hard currency revenues from oil exports. [ ]

**Will Moscow Increase Imports of Western Equipment and Technology?** The degree to which Moscow will be willing to buy more oilfield equipment from the West is not clear. While Western technology and equipment could reduce (or even prevent) some bottlenecks, we expect that purchases of equipment and technology from the West during 1986-90 will be made on a highly selective basis and at a slower pace than was in prospect before the fall in oil prices. Since late 1985, Moscow has cut back and deferred orders of some equipment and has vigorously pursued efforts to seek lower prices, better financing, and expanded countertrade agreements. [ ]

The themes of several of Gorbachev's speeches suggest that he is counting on the revitalization of the Soviet manufacturing industry to improve the general supply and quality of domestic oilfield equipment. From a technological standpoint, Western technology and equipment are not critical for most current Soviet oilfield operations. Much of the oil industry's effort will be concentrated in West Siberia, where the tasks of building infrastructure and accelerating the development of new oilfields—while formidable—do not call for sophisticated technology. [ ]

In all likelihood, however, Soviet equipment producers will be unable to keep up with the rapidly growing demand for oilfield equipment, increasing the pressure on Moscow to turn to foreign suppliers. Some

relief may be available from Eastern Europe, notably from Romania, but purchases from the West remain an option. Soviet buyers are currently engaging a wide range of Western suppliers in discussions for the purchase of oilfield equipment. Although such discussions are not novel, the unusually wide range of suppliers being contacted and the stress on financing terms suggest that the Kremlin is orchestrating its commercial inquiries to extract price and financing concessions. [ ]

Moscow's willingness to follow up these conversations with actual contracts remains problematic. Proposals to purchase Western oilfield equipment will be competing with requirements of the high-priority industrial modernization program as well as with equipment needs critical to the coal and natural gas development programs. But the continued heavy need for oil as both a prime energy product and a major source of hard currency will increase pressure on Moscow to spend whatever is necessary to keep oil output above 11 million b/d. Given Soviet hard currency problems, signings of substantial contracts would be a clear signal of the importance attached to maximizing oil production in the short and medium term. (Fortuitously, the current worldwide depression in the oilfield equipment industry will probably reduce the cost and leadtimes for whatever equipment is purchased.) [ ]

Regardless of the approach taken to cover for domestic production shortfalls, the Soviets will continue to obtain from the West some specialized equipment and technology that they cannot manufacture themselves or acquire from Eastern Europe. Emphasis will be on equipment for offshore operations and on specialized corrosion-resistant equipment and processing plants essential to exploitation of the deep, high-sulfur oil and gas fields of the Pre-Caspian Depression. [ ]

**Can Moscow Afford To Throw More Rubles at Oil?**

Investment funds are already spread thin and the investment requirements for even moderate success in sustaining oil output are high. Our most likely

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***The Oil Industry's Appetite for Steel: Still Growing***

*The demand for oilfield equipment will rise rapidly during 1986-90. To keep production around 11-1/4 million b/d, we estimate that the pace of drilling and well completions would have to increase by roughly 75 percent over the pace achieved during 1981-85. Some 7-8 million tons of high-quality seamless steel would be needed just to satisfy the increase in demand for well casing and production tubing. A substantial amount of drill pipe would also be needed. Although drill pipe is a reusable item, the Soviet press reports that a large share of the existing stock of drill pipe is old and fatigued. Large tonnages of steel would be needed for the increases in construction of gathering pipelines and storage tanks. The demand for wellheads and all types of valves would also grow rapidly. Overall, we estimate that at least an additional 15 million tons of steel would be needed to satisfy the increase in oil-industry demand for all types of steel products. Because much oil equipment requires high-quality steel, meeting the needs of the oil industry could result in shortfalls in delivering steel products to other sectors.*

scenario assumes that the Soviets will invest about 100 billion rubles in oil production and exploration during 1986-90.<sup>13</sup> The impact of investment of this magnitude is even more striking when translated into real terms; for example, into demand for steel (see inset). Failing to invest this much would almost certainly cause production to fall below 11-1/4 million b/d in 1990. Conversely, by investing roughly 125 billion rubles, Moscow, with luck, could probably succeed in keeping production hovering at about 12 million b/d.

Moscow plans for total investment to increase by about 4 percent annually during 1986-90. Gorbachev has indicated that, at the same time, investment in civilian machinery will nearly double, and roughly one-third of all investment will continue to go to the agro-industrial complex. If investment in oil doubles

<sup>13</sup> See appendix A for a detailed explanation of this investment estimate.

to the 100-billion-ruble range, planned increases in other areas, including other energy industries, will have to be trimmed. It is difficult to imagine where Gorbachev could find additional investment resources that would not have at least some adverse effect on investment allocations for his plan to modernize and revitalize the economy. For instance:

- Significant increases in investment in ferrous metallurgy will be necessary to provide the higher quality steel for the machinery required by Gorbachev's ambitious modernization program.
- Without increases in investment for the consumer, Gorbachev risks worker discontent that could counter efforts to raise productivity.
- The pressure for more investment in transportation will be especially acute as demand increases for roads and other infrastructure to support development in the more costly and inhospitable arctic and eastern regions—areas critical to Soviet plans to buttress energy production.
- Shortchanging the other energy sectors, most likely coal but perhaps even gas, could jeopardize the USSR's long-term energy program (see inset). We expect that Moscow would try to avoid the consequences of such a reduction by bringing about productivity gains to compensate for any cuts in investment.
- The loss of the electric power generating capacity of the Chernobyl' plant and of the 11 others of the same type while the Soviets make safety-related modifications will boost the need for fossil-fueled (fuel oil, gas, coal) generation of electricity. This activity has significantly increased the short-term risk associated with cutting back investment for any fuel. We estimate that each month about 130,000 b/d of oil equivalent would be needed to replace the loss in output of electric power by the Chernobyl' plant alone. As each of the other reactors is shut down for modifications, monthly power plant demand for fossil fuel could increase by an additional 30,000 b/d of oil equivalent.

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**Will Moscow Opt for Lower Oil Production?** Moscow could decide that its production goals are too costly, given alternative demands for limited investment funds. A policy of lower oil production, however, would imply acceptance of a reduction in oil exports for hard currency and cuts in oil exports to Eastern Europe. Key indicators of such an abrupt shift in Soviet oil policy would be:

- Statements from high-ranking government or party officials questioning the wisdom of a production-oriented policy, followed by a plateau in investment allocations for oilfield development and an increase in investment for exploration, particularly in the Barents Sea.
- More incidents of rationing of oil products and press reports rationalizing that high oil production levels are no longer necessary because of the "successful" implementation of an oil substitution and conservation program.
- A crash effort—probably involving large imports from the West—to bring on line additional secondary refining units to increase the share of light products, such as gasoline and diesel fuel, per barrel of oil processed. This would facilitate the production of the necessary volume of light products, should less crude oil be available for primary refining.

The likelihood of such a policy shift, however, appears remote. Moscow imports a large volume of grain and other foodstuffs; these account for about one-third of its hard currency import bill. Sustained improvements in the agricultural sector leading to a reduction of those imports would be almost mandatory before Moscow could safely throttle back oil production and exports, especially in view of falling oil prices. Such improvements are unlikely. Without such offsets, Gorbachev is unlikely to sanction lower oil production targets.

Moreover, given the announced growth goals, the mix of Soviet industrial output over the next five years is likely to become more, rather than less, energy intensive. Much of the Soviet capital stock is aged and guzzles fuel. The production of large quantities of new

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### **Competition Within the Energy Sector**

*Because sustained growth in oil production is not likely, the Soviets must also continue to emphasize gas development and accelerate development of other energy resources. Soviet planners have been counting on coal and nuclear power to provide nearly all new energy output once natural gas production levels off in the mid-1990s.* [ ]

*Before the Chernobyl' disaster, Moscow planned to double the electricity generating capacity from nuclear power plants during 1986-90. We estimate that investment in planned nuclear power facilities for those years may well be in the 20-billion-ruble range. Investment in the coal industry would also have to grow substantially for the Soviets to establish a basis for meeting their long-term goals for coal; this would require large-capacity lignite-fired boilers, ultra-high-voltage transmission systems, coal-slurry pipelines, and synfuel plants. Thus, within the energy sector, the competition for investment resources will be intense. We judge that coal will most likely be the sector shortchanged, because the payback from much of the coal-related investment is uncertain and most of the benefits would not be realized until the mid-1990s. But not meeting the short-term needs of the coal industry will make it very difficult for the industry to provide its expected share of increased energy production after 1995.* [ ]

*Gas production will continue to increase rapidly, although some slackening in the pace of development is possible. In addition to the tight investment situation, factors favoring such a slowdown include the hard currency shortage (construction of a gas transmission pipeline uses a large volume of Western linepipe and other items), unanticipated difficulties in developing the Yamburg gasfield, and weak demand for gas exports.* [ ]

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energy-efficient machinery—a goal of the industrial modernization program—is not only difficult, expensive, and time consuming but also requires large amounts of energy. The payback is uncertain, and significant benefits would not be realized before the 1990s. Lowering oil production goals—without cutting back oil exports and with the existing level of energy consumption—could quickly lead to energy constraints on economic activity. Because of the need to maintain economic stability and reduce political tensions in Eastern Europe, we believe that the Soviets cannot afford to cut oil exports to Eastern Europe drastically. [ ]

the Barents Sea. Ultimately, the impact of declining oil production during the 1990s will depend on Soviet success in moving the economy toward greater energy efficiency, in building secondary refining units to produce light products from heavy fuel oil, and in substituting gas for oil. Although there is time to make these improvements, the high resource costs associated with attempts to sustain oil output at a high level will impede efforts to begin rigorous implementation of these programs. [ ]

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For these reasons, we believe that, if oil production began to fall rapidly, Gorbachev would increase investment in the oil sector and that investment in other parts of the energy sector—as well as in transportation, the modernization program, agro-industry, and perhaps even the military—would be cut in varying degrees. [ ]

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#### **The Bottom Line**

Oil production is likely to fall by nearly 1 million b/d, to about 11-1/4 million b/d in 1990. If Moscow—as expected—is unable to substantially reduce domestic oil consumption, oil exports would have to be cut. We believe that exports to hard currency countries would bear the brunt of any reduction in oil production. Investment requirements to keep oil production near 11-1/4 million b/d, albeit large, are probably not overly threatening to Gorbachev's economic agenda. [ ]

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The possibility exists, however, for oil production to fall more sharply. In this circumstance, we judge the political and economic imperatives would compel the leadership to devote more resources to the oil industry and cut investment for other programs. [ ]

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After 1990, Soviet oil production could be in an even more precarious position. Reserves from most of the present complement of major West Siberian oilfields, which were developed during the late 1960s and early 1970s, will be virtually exhausted. Barring the discovery of giant oilfields, national output could fall sharply, and the Soviets would need to bring on line substantial capacity from a new oil region, perhaps





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## Appendix A

### How Much Investment Is Needed in 1986-90?

To keep oil production at about 11-1/4 million barrels per day (b/d) during 1986-90, the Soviets would need to drill as much as 190-200 million meters and to complete 75,000 to 80,000 new wells averaging 2,600 meters in depth. We estimate that total investment for these minimum considerations will amount to roughly 100 billion rubles, three-fourths of which will be spent on West Siberian oil development. [ ]

Investment in the oil industry has increased markedly—from about 4.2 billion rubles in 1975 to more than 11 billion rubles in 1985. Replacement of capacity that will be depleted will be the chief consideration affecting Soviet oil investment decisions during 1986-90. The portion of gross capacity added nationwide that merely offsets depletion of online capacity has increased sharply, from 1.2 million b/d in 1975 to 2.7 million b/d in 1980 (table 4). Moreover, the investment and manpower requirements for developing new capacity have escalated dramatically—particularly in West Siberia. To offset increasing depletion, the Soviets will have to step up sharply the pace of development drilling and well completions at steeply escalating cost. In 1985, the Soviets planned to drill 29 million meters (we estimate 28 million meters were actually drilled) to complete an estimated 12,000 wells nationwide. [ ]

#### West Siberian Investment, 1986-90

Almost 18 million meters were drilled in West Siberia in 1985, increasing the region's stock of wells by 6,500 and providing a gross addition of roughly 1.25 million b/d of new capacity. About 7.5 billion rubles were invested in West Siberia, roughly two-thirds of the total amount spent by the oil industry that year. The cost for a unit of new capacity in West Siberia has increased substantially in recent years because of steadily falling well flows, increasing well depths, the development of more remote fields, and the rapid

transition from free-flowing wells to wells on pump.<sup>14</sup> (Press reports indicate that six out of seven new wells require pumping equipment from the onset of production.) [ ]

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Because the productivity of West Siberian drilling crews remained virtually the same during this period, the drilling cost for providing a barrel of new capacity from the region in 1985 was six to seven times as great in 1985 as in 1975. (Our estimates for the increase in West Siberian drilling costs between 1975 and 1985 are consistent with Soviet data for the 1975-80 period, which show drilling costs tripling.) [ ]

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In addition, the cost of maintaining existing online production capacity grew as increasing volumes of water were injected to maintain reservoir pressure. The water cut increased from 15 percent in 1975 to 50 percent in 1985, and the cost of maintaining and establishing the entire water injection, handling, and disposition system rose accordingly. Because of age and lack of effective corrosion inhibitors, many of the water- and oil-handling systems are now being taken out of service more frequently for repair and replacement. At the Samotlor oilfield, thousands of barrels of oil are reportedly not produced each day because of shutdowns of leaking lines and equipment. [ ]

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Plans call for 130 million meters of development drilling in West Siberia during 1986-90. We estimate that drilling costs per meter are likely to increase

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<sup>14</sup> Average well depths increased from 2,200 meters in 1975 to roughly 2,600 meters in 1985. The efficiency of Soviet turbodrills falls sharply as the depth increases. Drilling wells 2,200 meters deep in West Siberia is routinely accomplished in five to six days, whereas drilling 500 to 700 meters deeper can take up to a month. [ ]

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**Table 4**  
**Soviet Oil Industry Investment, 1975-85<sup>a</sup>**

	1975	1980	1981	1982	1983	1984	1985
Annual investment (billion 1984 rubles)	4.2	7.5	8.9	9.6	10.0	10.3	11.5
Oil production (million barrels per day)	9.82	12.03	12.18	12.25	12.33	12.22	11.9
Gross capacity added (million b/d)	1.8	3.0	2.9	2.6	2.8	2.6	2.4
Depleted capacity (million b/d)	1.2	2.7	2.7	2.5	2.7	2.7	2.7
Development wells drilled	4,200	8,475	8,864	9,000	11,000	11,750	11,800
New-well flows (b/d) <sup>b</sup>	440	365	330	290	255	220	204
Average well depth	2,119	1,852	2,166	2,311	2,100	2,195	2,375

<sup>a</sup> Investment for oilfield equipment (drilling and well completions) and oilfield construction (well pads, gathering pipelines and centers, oil treatment facilities, and storage tanks).

<sup>b</sup> Average daily oil flow from new wells.

about 20 to 25 percent. Thus, drilling 130 million meters during the five-year period would cost about 30 billion rubles, and investment in all phases of West Siberian oil development would amount to roughly 70 billion rubles. This assumes that the productivity of drilling crews continues to show little improvement, while costs rise because of worsening geologic conditions, deeper wells, and increasing remoteness of fields from existing infrastructure. [ ]

We believe that investment in oilfield construction will—at a minimum—have to double, reaching an estimated 25-30 billion rubles. During 1986-90, the Soviets plan to bring on line 60 to 75 oilfields—about the number of fields brought on line during 1965-85. Although nearly all of the new fields are much smaller than those currently in production and will probably require less equipment and construction per field, the sheer increase in the number of fields implies a substantial increase in investment for oil-field construction. [ ]

We estimate that the cost of maintaining and servicing the well inventory and other support activities will double during 1986-90 to about 12 billion rubles. The press also suggests that the productivity of well-repair brigades is not improving. Press reporting indicates that the support infrastructure for oil production has been sorely neglected in recent years and that a substantial increase in investment is needed to redress this imbalance between production and support. [ ]

#### Exploration Costs

Recently, Soviet economists have indicated that most geologic and exploratory drilling costs associated with the search for oil and gas are paid from the geology ministry's current budget, paralleling Western practice. The economists also indicated that, for individual oilfields, the costs of geologic exploration amount to roughly 30 percent of the cost of producing a barrel of oil. [ ]

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The chief Tyumen' geologist recently announced that exploration drilling would double in 1986-90, to 14 million meters, from 6.9 million meters in 1981-85. With the average exploration drilling cost rising to about 1,000 rubles per meter in 1990, the new Tyumen' drilling plan could boost total outlays for exploration by 10 billion rubles in 1986-90, over and above the officially reported oil-industry investment projections for this period. [ ]

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### **Investment Outside West Siberia**

In the oil regions outside West Siberia, the USSR completed about 45 million meters of development drilling and added roughly 25,000 wells during 1981-85—about 9,000 more than were added during 1976-80. Although the collective output from these regions has been falling since 1975, the rate of decline has slowed in recent years. We believe that holding the average annual decline in output to about 140,000 b/d would require increasing investment in these regions about 50 percent from the 1981-85 level—to about 25 billion rubles—to provide for 60-70 million meters of development drilling and 35,000 new-well completions during 1986-90. [ ]

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Most of these oil-producing regions are old; the individual oilfields are small, deep, and complicated. Additional capacity from key fields in Kazakhstan and in the Caspian Sea that are slated for expansion or new development will be expensive. In Kazakhstan, the oil is either heavy (requiring costly EOR techniques) or contains dangerous amounts of hydrogen sulfide (requiring the use of expensive imported corrosion-resistant equipment). Development of Caspian Sea oilfields—in particular, the Kaverochkin field—will be more costly as the Soviets venture into deeper waters. [ ]

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## Appendix B

### Prospects for Gas Condensate Production

Despite the potential for substantial increases in condensate production and the numerous press statements emphasizing its importance to the national economy, we believe that output will grow slowly—by about 30,000 b/d annually—during 1986-90. About half the new production capacity will be needed to offset declining gas condensate production from aging gasfields elsewhere in the USSR. Recent press reports indicate that the oil and gas ministries still seem uninterested in processing gas condensate. Moreover, these reports note that the organization and planning for the production, processing, and disposition of condensate in West Siberia is in disarray. [ ]

Gas condensate—light-to-intermediate hydrocarbons produced from both gasfields and oilfields—is usually brought to the surface along with natural gas.<sup>15</sup> Processed components of condensate are used as petrochemical and refinery feedstocks, liquefied petroleum gas, gasoline, and diesel fuel. The Soviets have historically neglected the important energy and chemical value of condensate and have not made extensive use of it in the economy. Much of the condensate is comingled with the crude oil sent to refineries, but some is flared (burned), left in natural gas reservoirs, or simply lost because of a lack of processing facilities. [ ]

Gas condensate output rose steadily from roughly 270,000 b/d in 1975 to 600,000 b/d in 1982.<sup>16</sup> Urengoy's condensate reserves, however, have been brought on line slowly. As a result, condensate output remained virtually level during 1983-84. We believe that condensate output grew slightly in 1985 as new capacity from Karachaganak and Urengoy finally came on line. [ ]

<sup>15</sup> The condensate plus methane produced from oilfields is often referred to as associated gas. The condensate (usually butanes and heavier hydrocarbons) liquefies at lower temperatures and higher pressures, hence its name. [ ]

Several of the most important future condensate-producing fields, such as Astrakhan' and Karachaganak, are more than 4,000 meters deep and have extremely high levels of corrosives, including toxic hydrogen sulfide. Successful exploitation of these fields will require imports from the West of drilling equipment and corrosion-resistant production and processing equipment that the Soviet oil-equipment industry is currently unable to manufacture. [ ]

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#### Regional Plans for Increasing Gas Condensate Production in North Tyumen'

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Gas condensate production from the Urengoy and Yamburg gasfields is far behind schedule. Urengoy was scheduled to produce roughly 50,000 b/d in 1984 and 100,000 b/d in 1985. However, filling of the pipeline (400,000 b/d capacity) to transport condensate to Surgut did not commence until early 1985. As a result, roughly 50 wells in the condensate-producing formation at Urengoy were shut in and not producing during 1984. Press reports indicate that 150 wells had been completed by the end of 1985. On the basis of an estimated 100 well completions per year, reported gas flows per well, and the reported amount of condensate per cubic meter of gas produced, we estimate that the Soviets could increase condensate production by 50,000 b/d annually for at least a decade. This, however, is an optimum case and assumes that the processing plant will be working properly. [ ]

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[ ] the Soviets are seeking turbo-expander technology for use at facilities where gas is separated from liquids. We consider the most likely scenario for condensate production from the north Tyumen' gasfields to be a slow increase of about 30,000 b/d annually. [ ]

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#### Astrakhan'

Development of the Astrakhan' gas condensate field was launched in early 1983 with the award of a \$400 million contract to a French firm for a gas separation

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and treatment facility. This plant and the awarding of the field portion of the contract to a West German firm represent the first stage of planned development at Astrakhan'. Because of the high levels of hydrogen sulfide and carbon dioxide in the gas and condensate stream, the Soviets were forced to turn to the West to obtain the necessary high-quality equipment. First-stage development will eventually produce 50,000 to 60,000 b/d of condensate. Press reports indicate that drilling is proceeding slowly and that the project is behind schedule. In 1985, the Soviets awarded the plant portion for second-stage development—with identical production goals—to the same French engineering firm. The Soviets at first planned to act as the general contractor for the field development portion, but they have recently named a Canadian firm to head a consortium to oversee field development.

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**Karachaganak**

Production at Karachaganak began in late 1984, and, for the time being, the Soviets are shipping the gas and condensate 120 kilometers via new pipelines to Orenburg for final treatment. The existing plant at Karachaganak—which has the capacity to separate and prepare for pipeline transport 3 billion cubic meters of gas and 30,000 b/d of condensate from Karachaganak annually—and the gathering pipeline system were built by West German firms. Further development of the field awaits Moscow's decision on where to build the main gas-processing plant: Orenburg or Karachaganak. Initial reports indicate plans to eventually raise production to 20 billion cubic meters of gas and about 200,000 b/d of condensate annually. Negotiations are not planned to begin until mid-1986. Further increases in gas condensate output from Karachaganak probably will not be realized until the late 1980s. The producing formations at Karachaganak are deep (4,000 to 5,000 meters), and the gas contains high levels of corrosive compounds—hydrogen sulfide and carbon dioxide. Western equipment will be required because the Soviets do not have sufficient capability to make corrosion-resistant steels.

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**Figure 7**  
**Oil- and Gas-Producing Regions in the Soviet Union**



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